Form No. T611

Philadelphia University
Faculty of Engineering

Student Name:
Student Number:

Dept. of Electrical Engineering
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Course Title: Electrical Machines I	Date: 19/12/2017
Course No: (610314)	Time Allowed: 50 Minutes
Lecturer: Dr. M. Abu-Naser, Dr. F. Obeidat	No. of Pages: 3

Question 1: *This question is related to multiple choices* *(5Mark)*

1) Which type of induction motor we can insert external resistance into the rotor circuit?

(a) Wound rotor
b) Squirrel cage
c) Double squirrel cage
d) All of the above

2) Regarding rotor core loss of induction motors, which of the following statements is true?

(a) Rotor core loss is small because rotor current frequency is low
b) Rotor core loss is small because rotor current frequency is high
c) Rotor core loss is large because rotor current frequency is low
d) Rotor core loss is large because rotor current frequency is high

3) The starting (inrush) current in induction motor can be reduced by:

(a) Star Delta starting
b) Use of damper windings
c) Reducing the supply frequency
d) (a)+(b)

4) Single phase two winding transformer is connected as autotransformer. Efficiency of autotransformer is

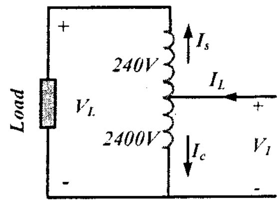
a) lower than the efficiency of single phase two winding transformer
b) Equal to the efficiency of single phase two winding transformer
(c) higher than the efficiency of single phase two winding transformer
d) Not determined

5) The electric circuit model of a three-phase induction motor is most similar to that of:

(a) transformer with secondary shorted
b) transformer with secondary open
c) synchronous motor
d) None of the above

Question 2: *This question is related to auto-transformer* *(6Mark)*

A single-phase 20kVA, 2400/240V, 50Hz transformer which is connected as an autotransformer as shown in the figure. Calculate.



1) **The current (I_s).**
2) **The current (I_c).**
3) **The current (I_L).**
4) **The voltage (V_I).**
5) **The voltage (V_L).**
6) **KVA rating of auto-transformer.**
7) **Percent increase in KVA of autotransformer as compared to original single phase two winding transformer (rating advantage)**

\ 1) $I_s = \frac{20KVA}{240} = 83.\bar{3}$ A

\ 2) $I_c = \frac{20KVA}{2400} = 8.3\bar{3}$ A

\ 3) $I_L = I_s + I_c = 91.6\bar{6}$ A

.5 4) $V_I = 2400$ V

.5 5) $V_L = 240 + 2400 = 2640$ V

\ 6) $KVA = 2640 \times 83.3\bar{3} = 220$ KVA

or
$KVA = 2400 \times 91.66 = 220$ KVA

\ 7) Percent increase in KVA rating $= \frac{220 KVA}{20 KVA} \times 100\%$

$= 1100\%$

Question 3: This question is related to three phase induction machines (9Mark)

An 8-pole, 3-phase, 50Hz, induction motor is running at speed of 710*rpm* with an input power of 35kW. The stator losses (copper and iron losses) at this operating condition are 1200W and the rotational losses are 600W. Find:

1- Rotor current frequency.
2- The slip at 710 *rpm*.
3- Air gap power.
4- Rotor copper losses.
5- Air gap torque.
6- The mechanical power.
7- The output power.
8- The output torque.
9- Motor efficiency.

1) $f_r = s f_s$

.5 $N_s = \frac{120 f_s}{P} = \frac{120 \times 50}{8} = 750$ rpm

.5 $s = \frac{750-710}{750} = 0.053\bar{3}$

1 $f_r = s f_s = 0.0533 \times 50 = 2.6\bar{6}$

2) $s = 0.053\bar{3} = 5.3\bar{3}\%$

1 3) Air gap power $= P_{in} - P_{\text{stator losses}} = 35000 - 1200 = 33800$ W $= 33.8$ KW

1 4) rotor copper losses $= s \times$ air gap power $= 0.0533 \times 33800 = 1800$ W $= 1.8$ KW

1 5) Air gap torque $= \frac{\text{Air gap power}}{\omega_s} = \frac{33800}{\frac{2\pi \times 750}{60}} = 430.36$ N.m

1 6) Mechanical power = Air gap power − rotor copper losses $= 33800 - 1800 = 32000$ W $= 32$ KW

1 7) output power = Mechanical power − rotational losses $= 32000 - 600 = 31400$ W $= 31.4$ KW

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8) output torque = $\frac{\text{output power}}{\omega_m} = \frac{31400}{\frac{2\pi \times 710}{60}} = 422.3\ N.m$

9) $\eta = \frac{\text{output power}}{\text{Input power}} \times 100\% = \frac{31400}{35000} \times 100\% = 89.7\ \%$